⑲ 日本国特許庁（JP）　　⑪ 特許出願公開

⑫ 公開特許公報（A）　　昭60-214931

⑤Int.Cl.⁴	識別記号	庁内整理番号	㊸公開 昭和60年(1985)10月28日
B 29 C 65/16		2114-4F	
C 08 J 5/12		7446-4F	

審査請求 有　発明の数 1　（全4頁）

⑭発明の名称　異種合成樹脂材料の接合方法

㉑特　願　昭59-72256

㉒出　願　昭59(1984)4月10日

⑫発明者　中俣　秀夫　豊田市トヨタ町1番地　トヨタ自動車株式会社内

⑪出願人　トヨタ自動車株式会社　豊田市トヨタ町1番地

明　細　書

1．発明の名称

異種合成樹脂材料の接合方法

2．特許請求の範囲

異種の合成樹脂材料を重ね合わせて両者を接合するに当り、前記異種の合成樹脂材料のうち、一方をレーザ光に対して非吸収性とするとともに、他方をレーザ光に対して吸収性とせしめ、この両者の合成樹脂材料を重ね合わせた後、前記レーザ光に対して非吸収性の合成樹脂材料の方向からレーザ光を照射することを特徴とする異種合成樹脂材料の接合方法。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は、異種の合成樹脂材料を重ね合わせ、その両者をレーザ光によって接合させる方法に関するものである。

〔従来技術〕

従来、合成樹脂材料と合成樹脂材料とを接合する際には、熱を加えて溶着する物理的接合方法と接着剤を用いて接着する化学的接合方法が広く利用されている。

すなわち、前者の物理的接合方法は、接合しようとする合成樹脂材料の接合面でメタルメッシュ等の発熱体を発熱させて両者の合成樹脂材料の接合面を溶融させつつ加圧・冷却し、両合成樹脂材料を接合する方法である。また、後者の化学的接合方法は、接合しようとする合成樹脂材料の接合面にホットメルト等の接着剤を介在させ、一方の合成樹脂材料の表面から高周波または超音波を付与させて接着剤を加熱・溶融させた後、両者の合成樹脂材料を加圧しつつ冷却し、両合成樹脂材料を接合する方法である。

しかし、前者の物理的接合方法においては、同種の合成樹脂材料を接合する際には接合しようとする両者の合成樹脂材料の溶融温度が同一であるとともに、相溶性を有するので、両合成樹脂材料の接合には適しているが、異種の合成樹脂材料を接合する際には両者の合成樹脂材料の溶融温度が異なるとともに、相溶性が悪いことから、両合成

樹脂材料の接合は困難である。また、後者の化学的接合方法においては、同種の合成樹脂材料を接合する際には前者の物理的接合方法と同様に適しているが、異種の合成樹脂材料を接合する際には合成樹脂材料の材質によって接着剤の接着力が低下し、両合成樹脂材料を強固に接合することは困難である。

上述のようなことから、異種の合成樹脂材料を接合する際には、機械的接合方法が多く利用されている。その代表例を第3図に示すポリプロピレンとポリエチレンの接合方法によって説明する。

第3図においては、51はポリプロピレン樹脂からなる板部材であって、この板部材51の下部にはポリエチレン樹脂からなる板部材52が配設されており、このポリエチレン樹脂の板部材52とポリプロピレン樹脂の板部材51とは互いに対向する部位に貫通孔53a、53bが形成されている。そして、両板部材51、52の貫通孔53a、53bには上方からパッキン54を介在して螺子55が螺合され、両板部材51、52が接合されている。

しかしながら、このような機械的接合方法においては、両板部材51、52に貫通孔53a、53bを形成し、螺子55を螺合しなければならず、前記の物理的接合方法および化学的接合方法に比較して接合作業が煩雑となることはもとより、両板部材51、52に貫通孔53a、53bを形成する必要があることから、両板部材51、52の強度が低下する不具合がある。

〔発明の目的〕

本発明は、上記の不具合を解消するためになされたもので、その目的は異種の合成樹脂材料のうち、一方をレーザ光に対して非吸収性とし、他方を吸収性とせしめ、非吸収性の合成樹脂材料の方向からレーザ光を照射することにより、両合成樹脂材料の強度を低下させることなく、容易に接合をすることができる異種合成樹脂材料の接合方法を提供することにある。

〔発明の構成〕

上記の目的を達成するために、本発明に係る異種合成樹脂材料の接合方法の構成は、異種の合成樹脂材料を重ね合わせて両者を接合するに当り、前記異種の合成樹脂材料のうち、一方をレーザ光に対して非吸収性とするとともに、他方をレーザ光に対して吸収性とせしめ、この両者の合成樹脂材料を重ね合わせた後、前記レーザ光に対して非吸収性の合成樹脂材料の方向からレーザ光を照射するようにしたものである。

そして、レーザ光に対して非吸収性を有する合成樹脂材料としては、ポリプロピレン、スチレン－アクリロニトリル共重合体等を挙げることができ、レーザ光に対して吸収性を有する合成樹脂材料としては、カーボンブラック等の補助材料を添加したポリプロピレン樹脂、ガラス繊維で強化され、かつカーボンブラックが添加されたスチレン－アクリロニトリル共重合体等を挙げることができる。そして、これらの合成樹脂材料はレーザ光に対して非吸収性を有するものと、吸収性を有するものとの組み合せにおいて自由に選択して接合することができる。

また、異種合成樹脂材料の接合時に使用されるレーザとしては、ガラス：ネオジウム$^{3+}$レーザ、ＹＡＧ：ネオジウム$^{3+}$レーザ、ルビーレーザ、ヘリウム－ネオンレーザ、クリプトンレーザ、アルゴンレーザ、H_2レーザ、N_2レーザ等を挙げることができ、このうち、特にＹＡＧ：ネオジウム$^{3+}$レーザが最も適している。

また、異種合成樹脂材料の接合時に用いられるレーザの波長としては、接合する合成樹脂材料に適合した波長が必要であって1.06μm以下が最も優れており、その波長が1.06μm以上の場合には異種の合成樹脂材料の接合面を互いに溶融させて接合することは不可能である。また、レーザの出力においては、5Wないし30Wが適しており、その出力が5W以下の場合には異種の合成樹脂材料の接合面を互いに溶融させることができず、30W以上の場合には異種の合成樹脂材料が蒸発したり、変質したりして接合が不可能である。

〔実施例〕

以下、本発明の一実施例を図面に基づいて詳細

に説明する。

第1図は本発明に係る異種合成樹脂材料の接合方法を説明する概略断面図、第2図は第1図（d）のA部楕円内を拡大した断面図を示すものである。

第1図の（a）ないし（d）において、1はガラス繊維が添加されて強化されたスチレン－アクリロニトリル共重合体からなる板部材であって、この板部材1の原材料色はカーボンブラックが混入されて黒色となっており、1.06μm以下のレーザ光に対しては吸収性の性質を有している。

また、板部材1の上部にはポリプロピレン樹脂からなる板部材2が配設されており、その下面と板部材1との接触部が接合面3となっている。そして、この板部材2の原材料色は乳白色をしており、1.06μm以下のレーザ光に対しては非吸収性の性質を有している。

そして、第1図の（a）のようにセットされた異種合成樹脂材料からなる板部材1、2を接合する際には、第1図の（b）に示すようにポリプロピレン樹脂の板部材2の上面にYAG：ネオジウム$^{3+}$レーザの照射ノズル4を当接させるとともに、その照射ノズル4から波長が1.06μm、出力が20WのYAGレーザ光5を凸レンズ4aを通過させて照射する。

その際、YAGレーザ光5は、その波長と合成樹脂材料の吸収スペクトルとの関連によって、ポリプロピレン樹脂からなる板部材2に対して非吸収となるため透過する。この時、YAGレーザ光5は、その照射方向に対して直進するのでなく、単結晶構造をもたない合成樹脂材料においては、それが、散乱した状態で進む。そして、同じくYAGレーザ光に対して吸収性をもつスチレン－アクリロニトリル共重合体からなる板部材1と板部材2との接合面3に達し、ここにエネルギとして蓄積される。この蓄積されたエネルギ分布というのは、YAGレーザ光5があらかじめもっていたエネルギ分布に対して板部材1の透過の際の散乱によって不均一なエネルギ分布となる。そして、接合面3においては、このような不均一なエネルギ分布をもった加熱・溶融が行われるため、両板部材1、2とは互いに絡み合った接合を生じる。

この時、照射ノズル4からYAGレーザ光5を照射しつつ、第1図の（c）に示すように矢印B方向から加重を加え、両板部材1、2とを密着しておくことが必要ある。但し、これは照射ノズル4を用いずに他の手段、例えば、機械的クランプなどを用いて、あらかじめ両板部材1、2とを密着させておいてもよい。

その後、第1図の（d）に示すように照射ノズル4からYAGレーザ光5の照射を停止するとともに、照射ノズル4をポリプロピレン樹脂の板部材2から離反させ、両板部材1、2への荷重を取り除く。これにより、第2図に示すように両板部材1、2の溶融物が互いに入り込んで絡まった状態で硬化し、スチレン－アクリロニトリル共重合体からなる板部材1とポリプロピレン樹脂からなる板部材2とが強固に接合される。

また、YAGレーザ光5を照射しながら連続的に板部材2の面に沿って移動せしめるならば、その移動方向に対して加熱温度の勾配を生ずることになり、YAGレーザ光5のエネルギ分布の不均一性はさらに増調され、より一層強固な接合を得ることができる。

（発明の効果）

以上説明したように、本発明に係る異種合成樹脂材料の接合方法においては、一方の合成樹脂材料をレーザ光に対して非吸収性とするとともに、他方の合成樹脂材料をレーザ光に対して吸収性とせしめ、非吸収性の合成樹脂材料の方向からレーザ光を照射するようにしたから、両合成樹脂材料の接合面から互いに溶融されて接合されるので、両合成樹脂材料の強度を低下させることなく接合することができる効果がある。

また、本発明においては、異種合成樹脂材料の一方からレーザ光を照射して接合するようにしたから、両合成樹脂材料の溶融物が互いに入り込んで絡まるので、より強力に接合することができる効果がある。

また、本発明においては、異種合成樹脂材料の

一方からレーザ光を照射することによって、両合成樹脂材料が接合されるので、従来の機械的接合方法に比較して、異種合成樹脂材料の接合を容易に行うことができる効果がある。

また、本発明においては、異種合成樹脂材料を接合した際に、両合成樹脂材料の接合部にはねじ等の固定手段がないので、意匠効果を向上させることができる効果がある。

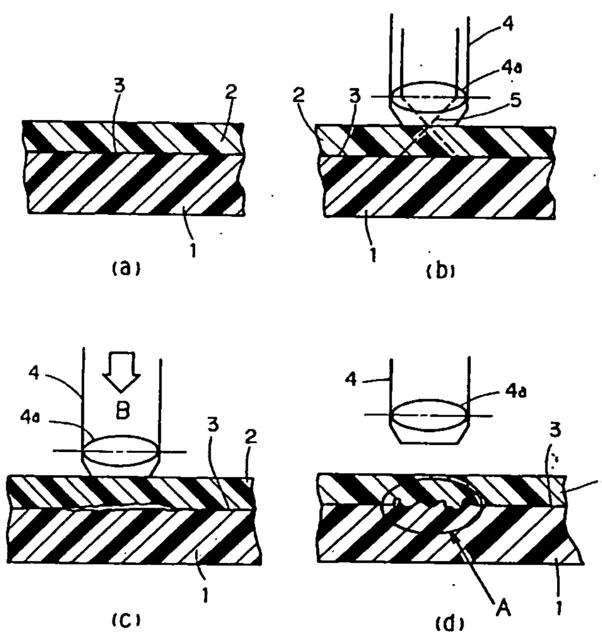
4．図面の簡単な説明

第1図は本発明に係る異種合成樹脂材料の接合方法を説明する概略断面図である。

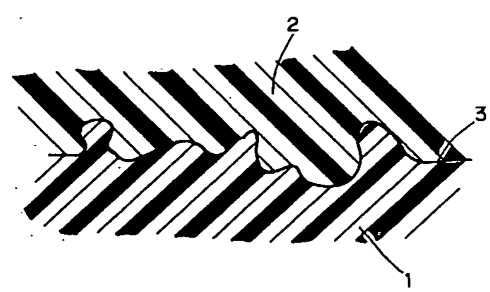
第2図は第1図（d）のA部楕円内を拡大した断面図である。

第3図は従来の異種合成樹脂材料の接合方法を説明する概略断面図である。

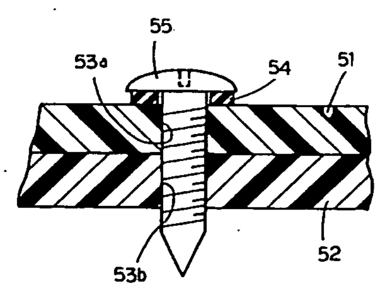
1………ガラス繊維で強化されたスチレン－アクリロニトリル共重合体からなる板部材
2………ポリプロピレン樹脂からなる板部材
3………接合面
4………照射ノズル
4a………凸レンズ
5………YAGレーザ光



第1図



第2図



第3図

Original document

BONDING OF DIFFERENT SYNTHETIC RESIN MATERIALS

Patent number: JP60214931

Publication date: 1985-10-28

Inventor: NAKAMATA HIDEO

Applicant: TOYOTA MOTOR CO LTD

Classification:

- international: C08J5/12

- european:

Application number: JP19840072256 19840410

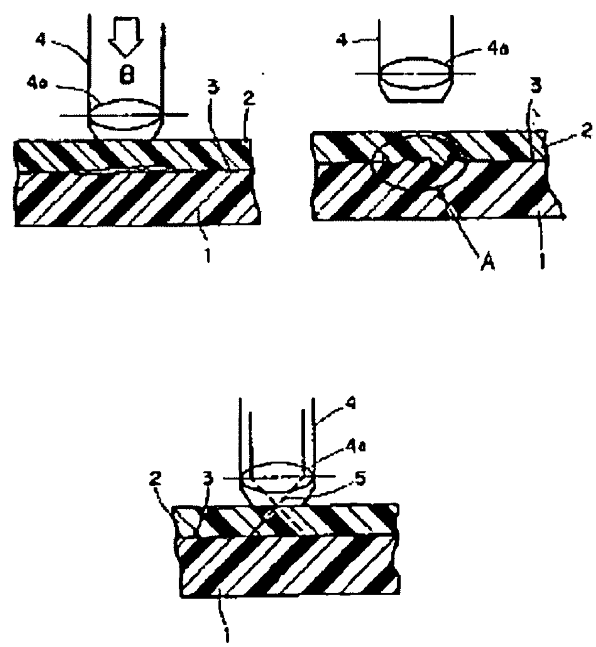
Priority number(s): JP19840072256 19840410

Also published as:

US4636609 (A

Abstract of **JP60214931**

PURPOSE:To bond different synthetic resin materials easily without deteriorating their strength by providing one non-laser beam absorbing synthetic resin material and other laser beam-absorbing synthetic resin material and transmitting laser beam from a direction of non-laser beam absorbing synthetic resin material.
CONSTITUTION:A glass fiber-reinforced plate member 1 of styrene acrylonitryl copolymer containing carbon black is absorptive to laser beams of less than 1.06mum. A plate member 2 of polypropyrene is milky and non-absorptive to laser beams of less than 1.06mum. A laser beam transmission nozzle 4 is caused to touch the upper surface of the plate member 2 of polypropyrene resin and YAG neodymium 3<+> laser beam 5 at wavelength of 1.06mum and output of 20W is transmitted through a convex lens 4a. The plate members 1, 2 shall be adhered together by applying weight from an arrow direction (B) because they are apt to be bonded in an entangled state on the bonded surface 3 on account of unevenly scattered energy distribution of YAG laser beam 5 caused by the plate member 1.



Description of corresponding document: **US4636609**

BACKGROUND OF THE INVENTION

The present invention relates to a process for joining differing kinds of synthetic resin to each other, anc more particularly to a process for joining them using the heat of a laser beam.

In a first conventional process for physically joining synthetic resins, each of the synthetic resins has a contact surface thereon. A metal mesh is disposed on the contact surfaces of the synthetic resins, and th(mesh is sandwiched between both of the synthetic resins. When the mesh is heated, both of the contact surfaces of the synthetic resins are melted by the heat of the mesh. Pressure then is applied to the outsid(of the synthetic resins to press them together, and the synthetic resins are cooled. As a result of this first conventional process, one of the synthetic resins is joined to the other of the synthetic resins.

In this first conventional process, both synthetic resins normally are the same kind of synthetic resins so that both will have the same melting point, and so that they will blend easily into one another. If differe kinds of synthetic resins are used, they may have differing melting points and may not blend easily into one another.

Further, in the first conventional process, a connecting wire is disposed between both of the contact surfaces of the synthetic resins to supply electricity to heat the mesh. Connecting the wire to the mesh between the synthetic resins requires an undesirably high amount of manual labor.

In a second conventional process for chemically joining synthetic resins, each of the synthetic resins ha contact surface thereon, and a bonding compound is disposed between both of the contact surfaces of th synthetic resins. The bonding compound normally is solid and is melted by heat, typically produced by applying high frequency or supersonic waves to the bonding compound. These waves also preferably m the synthetic resins slightly to improve bonding. After a compressive force is applied to the synthetic resins, the synthetic resins are cooled. As a result of the second conventional process, one of the synthet resins is joined to the other.

In the second conventional process, the synthetic resins again should be the same kind of synthetic resin this time so that the bonding compound has the same adhesive properties for bonding to both synthetic resins. If different kinds of synthetic resins are used, the bonding compound may have differing adhesiv properties as to the different kinds of synthetic resin. Accordingly, the adhesive strength of the bond to (kind of synthetic resin may be different from the adhesive strength of the bond to a different kind of synthetic resin, i.e., one bond may have a weak adhesive strength. Further, in the second conventional process with different synthetic resins, the synthetic resins may not both be melted by the heat of the hig frequency or supersonic waves.

FIG. 11 shows a third conventional process for mechanically joining different kinds of synthetic resins. shown in FIG. 11, a first plate 51 is mounted on a second plate 52. The first plate 51 is made of polypropylene resin, and the second plate 52 is made of polyethylene resin. The first plate 51 has a first hole 511, and the second plate 52 has a second hole 521 which is congruent with the first hole 511 of th(first plate 51. A washer 54 is mounted on the first plate 51, and a screw 55 is inserted into a hole of the washer 54, the first hole 511 and the second hole 521. As a result, the first plate 51 is joined mechanical

to the second plate 52.

However, in the third conventional process, the first hole 511 must be opened in the first plate 51, and tl second hole 521 must be opened in the second plate 52. Then, the screw 55 must be inserted. Each of th steps is undesirably labor intensive. Further, the screw 55 projects from both of the first plate 51 and the second plate 52, marring the appearance of the final product. In addition, when tension is applied to the first plate 51 and the second plate 52 in the horizontal direction in FIG. 11, the first plate 51 or the secor plate 52 may be torn at the first hole 511 or at the second hole 521, respectively.

SUMMARY OF THE INVENTION

The present invention has been developed in view of the facts as described above, and its object is to provide a process for joining different kinds of synthetic resins which enables secure joining of differen kinds of synthetic resins.

To accomplish the above-described object, a process for joining different kinds of synthetic resins inclu several steps.

A first step includes providing a first kind of synthetic resin, which can store up the heat from a laser be A second step includes setting a second kind of synthetic resin on a first kind of synthetic resin. A secor contact surface of the second kind of synthetic resin is in contact with a first contact surface of the first kind of synthetic resin. The second kind of synthetic resin can transmit the laser beam. A third step includes exposing an outer surface of the second kind of synthetic resin to the laser beam. The second k of synthetic resin transmits the laser beam, and the first kind of synthetic resin stores up the heat of the laser beam. As a result, the second contact surface of the second kind of synthetic resin is heated by the heat which is stored up in the first kind of synthetic resin. Accordingly, the first contact surface of the fi kind of synthetic resin and the second contact surface of the second kind of synthetic resin are melted by the heat which is stored up in the first kind of synthetic resin. While melted, they are pressed together, a cooled. Thus, the first contact surface of the first kind of synthetic resin is joined securely to the second contact surface of the second kind of synthetic resin.

Further, the outer surface of the second kind of synthetic resin does not have any scars, because the secc kind of synthetic resin simply transmits the laser beam and the heat of the laser beam is stored up in the first kind of synthetic resin.

Furthermore, neither the first kind of synthetic resin nor the second kind of synthetic resin can easily be torn, because neither has any holes therein.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and novel features of this invention will become more apparent from the description whicl follows, taken in conjunction with the accompanying drawings, and in which:

FIG. 1 is a cross-sectional view showing a second step of a first embodiment of a process according to t present invention;

FIG. 2 is a cross-sectional view showing a third step of the process;

FIG. 3 is a cross-sectional view showing a fourth step of the process;

FIG. 4 is a cross-sectional view showing a fifth step of the process;

FIG. 5 is an enlarged view of a portion of FIG. 4 showing a first contact surface of a first kind of synthe resin which is joined to a second contact surface of a second kind of synthetic resin;

FIG. 6 is a cross-sectional view showing a fourth step of a second embodiment of a process according tc the present invention, in which a first kind of synthetic resin includes fillers;

FIG. 7 is an enlarged view of a portion of FIG. 6 showing a first contact surface of the first kind of synthetic resin which is joined to a second contact surface of a second kind of synthetic resin;

FIG. 8 is a diagram showing the transmittance of 20 wt % glass filler reinforced styrene acrylonitrile copolymer with 0.1 wt % carbon black;

FIG. 9 is a diagram showing the transmittance of polypropylene without any additives;

FIG. 10 is a diagram showing the tensile strength of glass filler reinforced styrene acrylonitrile copolym and

FIG. 11 is a cross-sectional view showing a third conventional process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a first step of a process for joining different kinds of synthetic resins includes providing a first plate 1 made of a first kind of synthetic resin which can store up the heat of a laser beaı For example, the first kind of synthetic resin can be styrene acrylonitrile copolymer including 0.1 wt % carbon black as an additive. The first plate 1 of this composition is black. As shown in FIG. 8, the styreı acrylonitrile copolymer with carbon black transmits only a little of a Nd:YAG(Nd@+3 :Y3 Al5 O12) la beam and therefore can store up (absorb) most of the heat of the total amount of the laser beam. At 1.06 .mu.m, for example, this composition will transmit only about 4% of the beam. Alternatively, the f kind of synthetic resin may be polypropylene resin which includes carbon black as an additive.

Returning to FIG. 1, a second step of the process includes setting a second plate 2 on the first plate 1. Tl second plate 2 is made of a second kind of synthetic resin. The second plate 2 has a second contact surfa 21 which is in contact with a first contact surface 11 of the first plate 1.

The second kind of synthetic resin can transmit most of the laser beam, and preferably is polypropylene resin without any absorptive additive. As shown in FIG. 9, when the wavelength of the Nd:YAG laser beam is 1.06 .mu.m, the polypropylene resin without any additive can transmit about 75% of the total amount of the Nd:YAG laser beam. Alternatively, the second kind of synthetic resin may be styrene acrylonitrile copolymer, 6-nylon resin or 66-nylon resin, all without any absorptive additives. The color the plate 2 is milky white.

As shown in FIG. 2, a third step of the process includes setting a nozzle 4 of the laser beam on an outer surface of the second plate 2, and exposing the outer surface of the second plate 2 to the laser beam. The laser beam radiates from the nozzle 4 through a convex lens 41, and an end of the nozzle 4 preferably is contact with the outer surface of the second plate 2.

When the outer surface of the second plate 2 is exposed to the laser beam, the second plate 2 transmits tl laser beam, and the first plate 1 stores up the heat of the laser beam. As a result, the first contact surface

of the first plate 1 and the second contact surface 21 of the second plate 2 are melted by the heat which i stored up in the first plate 1.

A plurality of projections and a plurality of recesses are formed on the first contact surface 11 of the firs plate 1 and the second contact surface 21 of the second plate 2, because the laser beam is dispersed in th second plate 2 during transmission. Due to this dispersion, the laser beam concentrates on a plurality of spots which are located on the first contact surface 11 of the first plate 1 and the second contact surface of the second plate 2, and the laser beam melts a plurality of the spots. If the end of the nozzle 4 is not ir contact with the outer surface of the second plate 2, a larger plurality of the recesses may be formed by moving the nozzle 4 along the outer surface of the second plate 2 during irradiation by the laser beam.

With the preferred resins, the most suitable laser beam is a Nd:YAG laser beam, however, other laser beams may be used, including: Nd:glass laser beam; ruby laser beam; helium:neon (He:Ne) gas laser beam; krypton (Kr) gas laser beam; argon (Ar) gas laser beam; hydrogen (H2) gas laser beam and nitrog (N2) gas laser beam.

With the preferred resins, a suitable wavelength of the laser beam for joining different kinds of syntheti resins is about 1.06 .mu.m and less. When the wavelength of the laser beam is more than 1.06 .mu.m, th first kind of synthetic resin cannot be joined to the second kind of synthetic resin, because the second ki of synthetic resin cannot transmit the laser beam.

With the preferred resins, the laser beam should be from 5 W through 100 W in power in order to melt t first contact surface 11 of the first plate 1 and the second contact surface 21 of the second plate 2. When the generating power of the laser beam is less than 5 W, the first contact surface 11 of the first plate 1 ar the second contact surface 21 of the second plate 2 cannot be melted by the heat of the laser beam whicl stored up in the first plate 1. When the generating power of the laser beam is more than 100 W, the first contact surface 11 of the first plate 1 and the second contact surface 21 of the second plate 2 may vapori or may be transmuted, so that the first plate 1 cannot be joined to the second plate 2.

As shown in FIG. 3, a fourth step of the process includes applying a downward compressive force "F1 " the outer surface of the second plate 3 and the first plate 1 during exposing the second plate 2 to the lase beam. As best seen in FIG. 5, the melted first kind of synthetic resin of the first plate 1 is pressed into th plurality of recesses of the second contact surface 21 of the second plate 2. Similarly, the melted second kind of synthetic resin of the second plate 2 is pressed into the plurality of recesses of the first contact surfaces 1 of the first plate 1. Thus, a plurality of projections of the first contact surface 11 of the first pl 1 and a plurality of projections of the second contact surface 21 of the second plate 2 are formed. The fo "F1 " preferably is applied to the second plate 2 through the nozzle 4 of the laser beam, though the downward compressive force "F1 " may be applied to the second plate 2 through a different device, and while or after the second plate 2 is being exposed to the laser beam.

As shown in FIG. 4, a fifth step of the process includes stopping irradiation by the laser beam, and removing the nozzle 4 of the laser beam from the outer surface of the second plate 2. Concurrently, in th fifth step of the process, the downward compressive force "F1 " is removed from the second plate 2. Alternatively, the downward compressive force "F1 " may be removed from the second plate 2 after the nozzle 4 of the laser beam is removed from the outer surface of the second plate 2.

A sixth step of the process includes cooling the first plate 1 and the second plate 2, leaving the plurality the projections of the first contact surface 11 of the first plate 1 engaged securely with the plurality of th recesses of the second contact surface 21 of the second plate 2, and vice-versa.

Therefore, by this process, the first kind of synthetic resin can be securely joined to the second kind of

synthetic resin.

FIG. 6 and FIG. 7 show a fifth step of a second embodiment of a process according to the invention for joining different kinds of synthetic resins. Most of steps of the process in the second embodiment are th same as steps of the process in the first embodiment which is described above, however, the second embodiment has several differences. Description will be given hereunder of the several differences in th second embodiment.

A first kind of synthetic resin of a first plate 101 is styrene acrylonitrile copolymer. The styrene acrylonitrile copolymer is reinforced with 20 wt % glass filler 102, and the styrene acrylonitrile copolyn includes 0.1 wt % carbon black as an additive. Alternatively, the filler 102 of the first kind of synthetic resin may be a metal filler or a carbon filler instead of the glass filler.

As shown in FIG. 8, the styrene acrylonitrile copolymer can transmit only a little of a Nd:YAG (Nd@+3 :Y3 Al5 O12) laser beam. When the wavelength of the laser beam is 1.06 .mu.m, the reinforce styrene acrylonitrile copolymer can transmit about 4% of a total amount of the Nd:YAG laser beam. Therefore, the styrene acrylonitrile copolymer can store up most of the heat of the total amount of the la beam.

A second kind of synthetic resin of a second plate 2 is polypropylene resin which does not include any absorptive additives. As shown in FIG. 9, when the wavelength of the Nd:YAG laser beam is 1.06 .mu.ı the polypropylene resin without any absorptive additives can transmit about 75% of the total amount of Nd:YAG laser beam.

A third step of the process includes setting a nozzle 4 of the laser beam on an outer surface of the secon plate 2, and exposing the outer surface of the second plate 2 to the laser beam. The laser beam radiates from the nozzle 4 through a convex lens 41, and an end of the nozzle 4 is in contact with the outer surfa of the second plate 2.

When the outer surface of the second plate 2 is exposed to the laser beam, the second plate 2 transmits tl laser beam, and the first plate 101 stores up the heat of the laser beam. Therefore, the first contact surfac 11 of the first plate 101 and the second contact surface 21 of the second plate 2 are melted by the heat which is stored up in the first plate 101.

However, the glass filler 102 of the first plate 101 cannot be melted by the heat of the laser beam, and tl glass filler 102 therefore floats in the first kind of synthetic resin melted from the first plate 1 and the second kind of synthetic resin melted for the second plate 2 because the glass filler has a higher melting point than melting points of the first kind of synthetic resin and the second kind of synthetic. As a result shown in FIG. 6 and FIG. 7, a plurality of the fibers of the glass filler 102 will have ends in the first plat 101 and opposite ends in the second plate 2. Accordingly, some of the glass filler securely connects the first plate 101 to the second plate 2.

As shown in FIG. 10, the cohesiveness between the first plate 101 and the second plate 2 increases as th wt % of the glass filler increases. The data in FIG. 10 was obtained by joining the preferred first and second kinds of synthetic resins by the heat of a Nd:YAG laser beam, whose generating power is 87 W . whose wavelength is 1.06 .mu.m.

Therefore, in the process of the second embodiment, the first kind of synthetic resin can be joined secur to the second kind of synthetic resin through the glass filler 102.

As has been described above, according to the process for joining different kinds of synthetic resins of t

present invention, one kind of synthetic resin can be joined securely to a different kind of synthetic resir without any mechanical devices. Further techniques for joining different kinds of synthetic resins may b found in the following applications owned by applicant's assignee, filed concurrently with the present application and the disclosures of which are incorporated herein by reference: U.S. Ser. No. 720,153, fil Apr. 4, 1985; U.S. Ser. No. 720,156, filed Apr. 4, 1985; and U.S. Ser. No. 720,157, filed Apr. 4, 1985, a entitled "A Process for Joining Different Kinds of Synthetic Resins".

It should be apparent to one skilled in the art that the above-described embodiments are merely illustrati of a few of the many possible specific embodiments of the present invention. Numerous and varied othe arrangements can readily be devised by those skilled in the art without departing from the spirit and sco of the invention, which is defined by the following claims.

Claims of corresponding document: **US4636609**

What is claimed is:

1. A process for joining an article of a first kind of synthetic resin to an article of a second kind of synth resin comprising the steps of: providing a first article of a first kind of synthetic resin which can store up the heat of a laser beam; setting a second article of a second kind of synthetic resin on said first article, a first contact surface of said first article being in contact with a second contact surface of said second article, said second kind of synthetic resin being able to transmit said laser beam; and exposing an outer surface of said second article to said laser beam, whereupon said second article will transmit said laser beam to said first article, which will store up the heat of the laser beam so that the first contact surface o said first article and the second contact surface of said second article are melted thereby, and the first contact surface of said first article is joined to the second contact surface of said second article.

2. The process according to claim 1, wherein a plurality of projections and a plurality of recesses are formed on both the first contact surface of said first article and the second contact surface of said seconc article during said exposing step.

3. The process according to claim 2, wherein a plurality of the projections of the first contact surface of said first article engage with a plurality of the recesses of the second contact surface of said second artic to join the first and the second articles.

4. The process according to claim 1, wherein said first kind of synthetic resin comprises styrene acrylonitrile copolymer having an absorptive additive.

5. The process according to claim 4, wherein the additive of the styrene acrylonitrile copolymer is carbo black.

6. The process according to claim 1, wherein said first kind of synthetic resin comprises polypropylene resin having carbon black as an additive.

7. The process according to claim 1, wherein said second kind of synthetic resin is selected from the gro consisting of polypropylene resin, 6-nylon resin, 66-nylon resin and styrene acrylonitrile copolymer, all without any absorptive additives.

8. The process according to claim 1, wherein said laser beam is selected from the group consisting of a Nd:YAG laser beam, Nd:glass laser beam, ruby laser beam, helium:neon (He:Ne) gas laser beam, krypt (Kr) gas laser beam, argon (Ar) gas laser beam, hydrogen (H2) gas laser beam and nitrogen (N2) gas las beam.

9. The process according to claim 1, comprising the additional step of setting a nozzle of said laser bean on the outer surface of said second article before said exposing step.

10. The process according to claim 1, wherein the wavelength of said laser beam is not greater than abo 1.06 .mu.m.

11. The process according to claim 1, wherein a generating power of said laser beam is from 5 W throu 100 W in power.

12. The process according to claim 1, comprising the additional step of applying a compressive force to said second article and said first article during said exposing step.

13. The process according to claim 1, comprising the additional step of cooling said first article and said second article after said exposing step.

14. A process for joining an article of a first kind of synthetic resin to an article of a second kind of synthetic resin comprising the steps of: providing a first article of a first kind of synthetic resin which ca store up the heat of a laser beam and having a plurality of fibrous fillers; setting a second article of a second kind of synthetic resin on said first article, a first contact surface of said first article being in con with a second contact surface of said second article, said second kind of synthetic resin being able to transmit said laser beam; and exposing an outer surface of said second article to said laser beam, whereupon said second article will transmit said laser beam to said first article, which will store up th he of the laser beam so that the first contact surface of said first article and the second contact surface of sa second article are melted thereby, and the first contact surface of said first article is joined to the second contact surface of said second article.

15. The process according to claim 14, wherein after said exposing step, at least some of the plurality of fibrous fillers have ends in the first article and opposite ends in the second article, whereby at least some said filler connect the first article to the second article.

16. The process according to claim 15, wherein the fibrous fillers are selected from the group consisting glass fillers, metal fillers and carbon fillers.

17. The process according to claim 15, wherein said first kind of synthetic resin is selected from the gro consisting of styrene acrylonitrile copolymer and polypropylene resin, both having an absorptive additi

18. The process according to claim 17, wherein the absorptive additive comprises carbon black.

19. The process according to claim 15, wherein said second kind of synthetic resin is selected from the group consisting of polypropylene resin, 6-nylon resin, 66-nylon resin and styrene acrylonitrile copolyn all without any absorptive additives.

20. A process for joining an article of a first kind of synthetic resin to an article of a second kind of synthetic resin comprising the steps of: providing a first article of a first kind of synthetic resin which ca absorb the heat of a laser beam; disposing a second article of a second kind of synthetic resin on said fir article, a first contact surface of said first article contacting a second contact surface of said second artic

said second kind of synthetic resin being able to transmit said laser beam; transmitting said laser beam through said second article to said first article to heat up said first article, thereby melting said first and second contact surfaces of said first and second articles, and forming a plurality of projections and a plurality of recesses in each of said first and second contact surfaces; pressing said first and second artic together so as to press said plurality of projections of said first contact surface into said plurality of recesses of said second contact surface, and said plurality of projections of said second contact surface i said plurality of recesses of said first contact surface; and cooling said first and second articles, thereby leaving said pluralities of projections and pluralities of recesses engaged to join together the first and second articles.

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☑ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☑ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☑ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: ____________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.